Presentation to the
Animal Feeding of Distillers Grains Committee
September 13, 2007
Room 22 Capital Building
Des Moines, Iowa

Dan Loy
Professor of Animal Science
Iowa State University

Thank you for the opportunity to address this important topic. It is no secret that the ethanol industry is growing quite rapidly with Iowa being the center of it all. Livestock has historically and continues to be an important component of the Iowa economy, culture and landscape. The changes brought about in the farm economy by the ethanol industry represent at once a challenge and opportunity for livestock production in the State. Ethanol competes directly with livestock for corn having the effect of increasing feed costs. The ethanol industry also produces large quantities of co-products that have varying but significant nutritional value. Iowa livestock farms, especially beef farms benefit greatly from their proximity to ethanol plants and their high moisture feed co-products. Issues of concern to livestock producers often relate to variation in these co-products, optimum feeding levels and proper balancing of nutrients for their animals when diets are fed with varying levels of these feeds.

As background to some of these issues and concerns it is the intent of this presentation to give an overview of corn processing methods and the resultant feed co-products. This overview will be from the perspective of an animal nutritionist and not a process engineer. Typical analysis and potential variation of these feeds will be reviewed briefly as well as some discussion of typical methods of purchasing these products. Purchasing methods differ by feed product and therefore species of livestock. Finally economical feeding levels for beef cattle and factors that limit levels of feeding will be discussed.

Wet Milling Process
Wet mills historically are typically larger than dry mills and can produce corn sweeteners as well as ethanol. The wet milling process is very complex and produces a variety of products and by-products. Corn is steeped for 30 to 40 hours to begin the process of breaking the kernel down into its components. The germ is separated for the extraction of corn oil. The bran is screened, and then the starch is separated from the gluten. The steep water is condensed to the consistency of molasses and mixed with corn bran to produce corn gluten feed.

Corn Gluten Feed
Corn gluten feed is a popular feedlot cattle protein and energy source because it is an intermediate protein product that is rich in highly-digestible fiber. It is the highest volume co product of the wet corn milling industry. Dry corn gluten feed is often pelleted and marketed to domestic and European dairy industry. Corn gluten feed actually contains no gluten but a mixture of corn bran and condensed steep water solubles. It may contain corn

germ meal as well as other co product streams from the plant. Corn gluten feed can vary in composition due to the ratio of condensed steep water solubles to corn bran. This will vary from plant to plant depending on the markets available. Corn gluten feed that is higher in bran will be lower in protein, as well as phosphorous and sulfur

Corn Gluten Meal

Corn gluten meal is golden-yellow and is mainly gluten, the high protein portion of the corn kernel. Corn gluten meal is used primarily in the swine and poultry industries and is high in Xanthophyll, a yellow pigment the imparts yellow color to poultry. Corn gluten meal is a high bypass protein source and although expensive may be useful in beef diets that require bypass protein, such as lightweight calves.

Condensed Steep water Solubles

Condensed steep water solubles are an excellent source of soluble protein for liquid beef supplements. Most condensed steep water solubles are used in corn gluten feed, however, it has the consistency of molasses and can also be used in liquid supplements. It is about 35 percent protein and can be extremely high in phosphorous and sulfur.

Dry Milling Process

The vast majority of new construction of ethanol plants are dry mill plants. Corn is nearly two-thirds starch. The starch is the primary substrate for alcohol fermentation. Therefore, the nutrients in the remaining one-third of the corn kernel are concentrated into distillers feeds. The process begins by grinding the grain. Starch must be converted to sugar by enzymes before the yeast can ferment the sugar to produce ethanol and carbon dioxide. The fermentation process takes 40 to 50 hours. The ethanol is collected and refined. A centrifuge separates the distillers' grains from the solubles. The solubles can then be condensed to about 30 percent dry matter (condensed distillers solubles). These wet co products can then be used locally for livestock feed or to produce distillers dried grains, or distillers dried grains with solubles. While the dried grains can be transported longer distances, some feeding value may be lost and drying is expensive.

Products of the dry corn milling industry

Distillers Grains

Wet distillers' grains and distillers' grains with solubles contain the remaining nutrients after the corn starch is fermented to alcohol. Therefore, the original nutrients in the corn are concentrated approximately three times. Wet distillers' grains are higher in both protein and energy than corn gluten feed because gluten and oil remain in distillers grains. When distillers' grains are dried they lose some energy value compared to wet products. Dried distillers grains and distillers dried grains with solubles are marketed widely around the world as a feed commodity. Like corn gluten meal, dried distillers grains are a good bypass protein source for cattle.

Condensed Distillers Solubles

Distillers solubles can be added to the distillers grains, or condensed and used as a liquid cattle feed supplement. The protein level is typically lower and fat levels are typically higher than distillers' grains. Because condensed distillers solubles are 70 percent

moisture, upper Midwestern feeders should use heated or underground tanks to prevent freezing.

Modified Distillers Grains with Solubles

Many Iowa plants are now producing and marketing modified distillers grains with solubles. This product is intermediate in moisture between wet and dry distillers' grains with solubles at approximately 50% moisture. Modified distillers grains can be produced by partially drying wet distillers' grains with solubles. More often they are produced by adding additional solubles to dry or partially dried distillers grains. Because of the higher level of condensed distillers' solubles, modified distillers grains with solubles often are lower in protein and higher in fat than the wet or dry product.

Table 1 shows typical analyses of dry mill ethanol co product feeds along with corn gluten feed as a reference. Of note is the higher oil and lower protein level of the solubles. Therefore any differences in the process from plant to plant that varies the content of distillers solubles relative to the grains will change protein, oil and fiber levels. This is similar with corn gluten feed and the effect of varying levels of corn bran and steep water. A second source of variation in corn co products is sulfur. Sulfur not only is concentrated from the original grain, but is added in the process, in varying amounts, in the form of sulfuric acid. The following slides review the analysis discussed previously, along with pictures and expected variation in sulfur content (see attached). Notice that the sulfur content of condensed distillers' solubles tends to be higher than distillers grains. Therefore feed products that contain higher levels of solubles also tend to contain more sulfur. Since much of the sulfur is added during the process and relate more to the fermentation process and production cycles, sulfur levels tend to show more "within plant" variation than other nutrients.

The ethanol industry is an immature industry as witnessed by the current rate of expansion. Along with this are changes and innovations in production processes. These changes may improve efficiencies or improve yields of new products and biofuels. In any event, these changes can have a profound effect on the co product streams. One new process technology is fractionation. Fractionation is a prefermentation process that allows the separation of the germ for potential oil extraction. The resultant feed products include a high protein distillers grains, a germ meal product and a high fiber, low fat, low protein bran feed. The latter feed would be somewhat similar to corn gluten feed in analysis. Oil extraction of distillers dried grains with solubles is also possible. This process results in a feedstuff that differs from normal distillers grains only in its much lower oil content. Finally some plants may have the ability to partially remove the oil from the condensed distillers' solubles. This would have the result of reducing the oil content of any co product that contains solubles. Success of the biodiesel industry will likely increase the success of these newer innovations.

Marketing of distillers grains differs somewhat depending on the specific product. High moisture feeds tend to be marketed within reasonable proximity to a plant because of the high cost of transporting water. Dried distillers feeds are a global commodity. Because of these differences high moisture feeds tend to be marketed by a local broker. This

person may be an employee at the plant or associated with a local cooperative. To facilitate efficient global sales and distribution, dried distillers grains are often marketed by a specialized broker. This broker may sell feeds from several plants as well as deal in other commodities such as soybean meal, cottonseed meal, etc. Since the product may originate from plants with different processes in this system, more variation may exist in protein, oil and fiber content than when the feed originates from a single plant. Purchasing high moisture feeds though a local source from a single plant allows the feeder to develop a relationship with the seller including better knowledge of expected variation and forward contracting opportunities. Moisture and sulfur are the more common issues related to consistency with wet feeds.

Much research had been conducted in the past 10 years on the feeding of distillers feeds to beef cattle. Iowa State University, along with other Midwestern universities has led this effort. The research indicates that distillers' grains, particularly wet distillers grains are an excellent source of protein and energy for cattle. The data indicates that the energy value is equal to or exceeds the energy value of corn grain. At 15-20% of the diet dry matter, the level necessary to meet the protein demands of the cattle, distillers' grains contain 120-130% of corn grain on a dry matter basis. At higher levels wet distillers grains are at least equal to corn on a dry matter basis. Wet distillers' grains are higher in energy value that dry distillers' grains when adjusted for moisture based on research at Iowa State University.

Optimum feeding levels for growing and finishing beef cattle are driven by economics within the limitations of the levels of certain nutrients present in the feeds. An analysis conducted by the University of Nebraska and modified to account for the current distillers' grain-corn grain price relationship shows that the optimum level of feeding is 40% of the ration dry matter for feedlots within 30 miles of an ethanol plant. This is based on certain assumptions including transportation costs and cattle responses to feeding higher levels. The optimum feeding level when wet distillers' grains are transported greater distances, up to 100 miles, was 30% of the ration dry matter. These feeding levels added $10 to $30 per head compared to not feeding distillers grains. Optimum feeding levels may increase as the price relationship changes between corn grain and distillers' grains.

Typical fat or oil content of distillers grains limit their feeding to 40-50% of the ration dry matter. This assumes fat content of the distillers grains of approximately 10%. Higher oil levels would reduce feeding levels. Lower oil levels and "new generation" feeds that have reduced oil levels could potentially increase the feeding levels that cattle can tolerate. However, sulfur is typically the first limiting nutrient. Sulfur levels can range widely in distillers grains. Ranges of .5 to nearly 1% of feed dry matter are not uncommon. The National Research Council recommends a maximum tolerable level of .4% of the ration dry matter. This recommendation is based on limited data and some nutritionists advocate slightly higher levels. However, it is a good point of reference. If the distillers' grains are at the low end of the range, sulfur content would allow levels of feeding above 50% of the ration. If the distillers' grains are at the high end of the range, sulfur content would limit levels of feeding to 30% of the ration dry matter or less.

Farmers that have established relationships with plants and are comfortable in knowing the expected sulfur content can formulate feeding levels to minimize problems associated with sulfur toxicosis. However, if purchasing from an unknown source the feeder must assume the higher level to ensure safe feeding. This limits feeding levels.

Other challenges in feeding high moisture corn co products are the short shelf life of the wet feeds and the high phosphorous content. Phosphorous levels of the ration will exceed the animal requirement. Therefore manure phosphorous levels will be higher as well. This problem is manageable as Iowa has more than enough crop land to utilize the phosphorous, but changes in manure rates per acre may be necessary depending on crop uptake and other factors.

This presentation has focused primarily on the use of ethanol co products for cattle feeding. It should be mentioned that there are significant opportunities as well as challenges for cow- calf farms as well. As mentioned, distillers grains are excellent sources of protein, energy and phosphorous. All of these nutrients may need to be supplemented in a forage based diet. These feeds complement crop residues such as corn stover particularly well. Systems utilizing corn stalks and distillers' grains as primary feed sources can easily meet the nutrient needs of beef cows at all stages. Distillers' grains can also be used to stretch pasture and forage supplies. However, delivery systems for pasture and extensive systems remain a challenge. Also the small quantities needed for typically small cow-calf operations represent a storage challenge especially for the wet feeds.

In summary, the ethanol industry is growing and changing rapidly. The cattle business is changing and adapting to a changing economic environment. The co products of the ethanol industry represent a local resource that should benefit the economy of Iowa.